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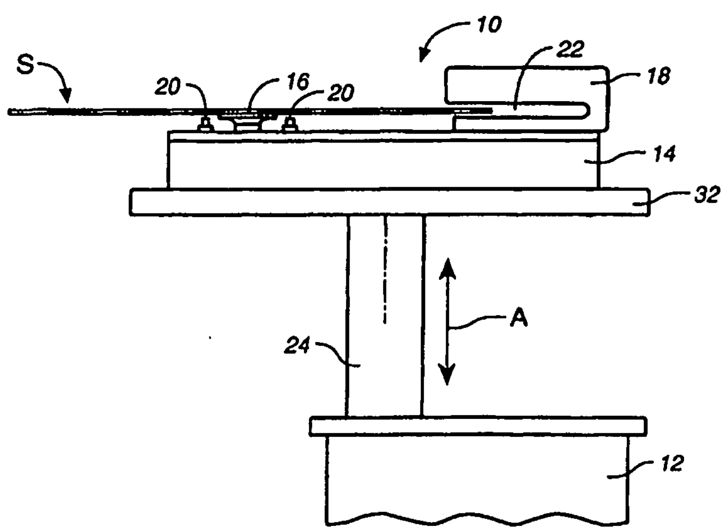

(57) Abstract

A robotic system includes a robot (40) having a robotic arm (42) for transferring substrates (S) between workstations and cassettes and a remote prealigner (10) for use in alignment of the substrates. The prealigner (10) is movable with respect to the robot (40) to allow adjustment of the prealigner position depending on the position of the robotic arm (42). The adjustable position prealigner (10) improves transfer time for delivery of the substrate (S) to the prealigner (10) with the robotic arm (42). The prealigner (10) can also be moved out of the way of the robotic arm (42) once prealignment has been completed and provides improved flexibility in arrangement of components within the robotic system. The prealigner includes a body (12) and a head (14) which is movable with respect to the fixed body (12) or base. The prealigner head includes a rotatable chuck (16) and a substrate edge detector (18) for acquiring and processing geometrical information.

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PREALIGNER FOR SUBSTRATES IN A ROBOTIC SYSTEM

Background of the Invention

Field of the Invention

The invention relates to an apparatus and method for performing substrate prealignment in the semiconductor wafer and flat panel display transporting and processing fields.

Brief Description of the Related Art

In the semiconductor wafer and flat panel display processing fields, robot arms with end effectors are used in moving substrates including semiconductor wafers, flat panels, reticles, and the like, to and from cassettes and workstations where various processing steps take place. The robot end effector and the workstations or cassettes where the substrates are held and processed must be properly aligned with one another so that the substrates can be transferred and positioned properly without damage.

Several different types of robot linkages are known in the art. These linkages include telescoping arms, rotatable link arms, and isosceles triangle-type linkages. Pulleys, belts, and motors are generally utilized to move the links of the robot arm with respect to one another and to move a robot end effector or hand located at the end of the arm which is used to grasp and transport a substrate. In use, the robot arm is extended to pick up a substrate located in a cassette or at a workstation with the end effector, generally by suction. The arm is then retracted and rotated to the position of another cassette or workstation. The robot arm

carrying the substrate is then advanced to another cassette or workstation where the substrate is deposited.

Prealigning is a process of dealing with a problem of angular and linear misalignment of a substrate by orienting and centering the substrate on the robot end effector. The misalignment problem is particularly prevalent when dealing with large substrates, such as large wafers and flat panel displays, because the large substrates are often present in cassettes with a certain degree of angular and linear misalignment. In addition, large substrates may cause a robot arm to deflect due to the heavy load of the substrate.

During prealignment, the substrate is centered and oriented so that a mark such as a flat or notch on an edge of the substrate is set at a predefined angled and a center of the substrate is positioned at a predefined location on the end effector. Prealigning ensures that successively processed substrates are all oriented with the mark in the same direction and are centered during processing. Prealigning also minimizes the risk that a substrate or carrier may be damaged.

Prealigners generally include a rotatable chuck and a lighthouse for sensing the location of an edge of the substrate. Prealigning is typically achieved by placing the substrate on the chuck of a prealigner with an edge of the substrate positioned in a lighthouse having light sensors such as CCD sensors. The chuck is then used to rotate the substrate over the light sensors to detect the degree of misalignment. Once the misalignment has been detected, the position of the substrate is adjusted accordingly.

In one type of prealigner, called a stand alone prealigner, the chuck is movable a direction parallel to a plane of the substrate. The movable chuck may be used to center and align the substrate on the robot end effector. The stand alone prealigner performs all the necessary motions for compensating for the displacement of the wafer center and correction of the orientation of the wafer peripheral marker (flat or notch). The stand alone prealigner has the drawbacks of

a relatively complex and expensive design and a fixed wafer exchange position requiring the robot arm to travel to the prealigner.

An integrated prealigner is an alternative to the stand alone prealigner. The integrated prealigner is a part of the mechanical construction of the robot. The integrated prealigner may move together with the robot arm. With the integrated prealigner the orientation of the prealigner head and the position of the prealigner chuck in the X-Y plane cannot be changed. The robot end effector alone may be used to center the substrate on the chuck, or a combination of the robot end effector and the chuck may be used for centering. The integrated prealigner may require the robot arm to bend into awkward positions to perform prealigning and the prealigner may be in the way of the robot arm when the prealigner is not being used.

Known prealigners have certain inherent limitations because the prealigners have a fixed wafer exchange position within a robotic system or with respect to the robot arm. The design of these prealigners requires the robot arm to transport the substrate to the wafer exchange location of the prealigner each time alignment is needed even though the substrates may be picked up at different locations within the robotic system requiring different travel distances depending on the pickup location.

Accordingly, it would be desirable to provide a prealigner which reduces travel time and distance and thus improves processing time for prealigning in a robotic system.

Summary of the Invention

The present invention relates to a prealigner for a robotic system including a prealigner body arranged to be mounted within the robotic system remote from a robot and a prealigner head movably mounted on the prealigner body to position the prealigner head at different positions with respect to the robot to improve

transfer time of the robotic system. The prealigner head includes a rotatable chuck for receiving and rotating a substrate and a substrate edge detector for detecting a substrate edge.

In accordance with another aspect of the present invention, a method of prealigning includes the steps of: picking up a substrate with a robotic arm; adjusting a vertical elevation of a prealigner to substantially match a vertical elevation of the substrate on the robotic arm; moving the substrate to the prealigner with the robotic arm; and prealigning the substrate.

In accordance with an additional aspect of the present invention, a robotic system includes a robot having a movable robot arm for transporting substrates and a prealigner which is movable with respect to the robot arm from a retracted position to an extended position to match an elevation of the robot arm with an elevation of the prealigner for loading and unloading the substrate.

The present invention provides the advantages of a robotic system having improved travel time for performing prelaignment and more beneficial utilization of internal space in the robotic system.

Brief Description of the Drawings

The invention will now be described in greater detail with reference to the preferred embodiments illustrated in the accompanying drawings, in which like elements bear like reference numerals, and wherein:

FIG. 1 is a side view of a prealigner according to the present invention with a substrate positioned at the prealigner;

FIG. 2 is a top view of the prealigner head of FIG. 1;

FIG. 3 is an enlarged top view of a portion of the prealigner head of FIG. 2;

FIG. 4 is a side view of the prealigner chuck and a U-shaped robot end effector;

FIG. 5 is a top view of the prealigner chuck and U-shaped robot end effector of FIG. 4;

FIG. 6 is a side view of a prealigner head having pins for use with a blade-type robot end effector;

FIG. 7 is a top view of the prealigner head of FIG. 6 and the blade-type robot end effector;

FIG. 8 is a top view of a robot and prealigner with the robotic arm in a pickup position;

FIG. 9 is a top view of a robot and prealigner with the robotic arm in a reference position.

FIG. 10 is a top view of a robot and prealigner with the robotic arm in a retracted position;

FIG. 11 is a side view of an alternative embodiment of a prealigner with two substrate edge detectors;

FIG. 12 is a top view of the alternative embodiment of the prealigner of FIG. 11;

FIG. 13 is a side cross sectional view of one embodiment of a prealigner lift mechanism;

FIG. 14 is a top view of a remote flat panel prealigner according to the present invention;

FIG. 15 is a side view of the remote flat panel prealigner of FIG. 14 in a retracted position; and

FIG. 16 is a side view of the remote flat panel prealigner of FIG. 14 in an extended position.

Detailed Description of the Preferred Embodiments

A robotic system according to the present invention includes a robot having a robotic arm for transferring substrates between workstations and cassettes and a

remote prealigner for use in alignment of the substrates. The prealigner is movable with respect to the robot to allow adjustment of the prealigner position depending on the position of the robotic arm. The adjustable position prealigner improves transfer time for delivery of the substrate to the prealigner with the robotic arm. The prealigner can also be moved out of the way of the robotic arm once prealignment has been completed. The remote prealigner is movable independent of the robot to provide a robotic system with improved flexibility in arrangement of components.

A prealigner 10 for acquiring and processing geometrical information is illustrated in FIG. 1. The prealigner 10 includes a body 12 and a head 14 which is movable in the direction of the arrow A with respect to the fixed body or base. The prealigner head 14 is mounted on a flange 32 which is supported on a support post 24 for vertical movement. The prealigner head 14 supports a rotatable chuck 16, a substrate edge detector 18, and optional lift pins 20. The chuck 16 holds and rotates a substrate S with an edge of the substrate positioned within a slot 22 of the substrate edge detector. The substrate edge detector 18 is used to measure the position of the substrate edge as the substrate is rotated preferable without touching the substrate surface. One example of a substrate edge detector 18 is a lighthouse including a light source positioned on one side of the slot 22 and a light sensor such as a CCD sensor positioned on a second side of the slot. The light sensor produces a signal proportional to the size of the shadow cast by the substrate S as the edge of the substrate crosses the lightbeam produced by the light source. The lift pins 20 can be moved up and down to lift the substrate off of the chuck 16 or the end effector of a robotic arm.

The prealigner head 14 is movable with respect to the prealigner body 12 along a vertical axis in the direction of the arrow A which is generally parallel to a Y axis of an associated robot by moving the support post 24. The movable prealigner head 14 allows the prealigner to be moved out of the way of the robot arm when the prealigner is not in use. The movable head 14 also allows the

prealigner to follow the elevation of the robot arm and provide a path for the robot arm to move a substrate to and from the prealigner with a minimum change in vertical elevation of the robot arm. The movable prealigner head 14 is particularly useful for high reach vertical applications, such as, when a tall substrate cassette or carrier is used and the robot picks up substrates at a variety of different vertical positions. Without the movable prealigner head, the vertical component of the path of the robot arm between the substrate cassette and the prealigner will increase as the robot moves along the slots in the cassette.

The prealigner head 14 may be moved in the direction of the arrow A with respect to the prealigner body 12 by any known method such as a lead screw, nut, and servo motor combination. Such a prealigner lift mechanism is illustrated in FIG. 13 and will be discussed in further detail below. Other prealigner lift mechanisms for achieving vertical motion include a rack and pinion, belt and slide, cam (for small travel), or the like.

The prealigner head 14 may also be rotatable, such as by rotation about an axis of rotation extending longitudinally through the support post 24. Rotation of the prealigner head 14 with respect to the base 12 allows adjustment of the angular head position in the robotic system to make the prealigner easily accessible by the robot end effector. The head 14 may be rotatable either manually or automatically to improve the transfer time by allowing simpler and quicker motions of the robot arm when transferring the substrate to and from the prealigner.

As illustrated in FIG. 3, the rotatable chuck 16 includes an upper surface for grasping the substrate. The chuck 16 may be provided with channels 26 in the upper surface through which a vacuum is applied to grip the substrate. A chuck material is preferably a material which generates minimal particles such as Viton (rubber), hard-anodized aluminum, quartz, or the like.

The substrate edge detector 18 may be movable in the direction of the arrow B toward and away from the chuck 16 along a track 30 as illustrated in FIG. 2. The movable substrate edge detector 18 allows the prealigner to

accommodate substrates of different sizes. A movable substrate edge detector 18 may also be moved out of the way during loading and unloading a wafer with an end effector. The commonly used wafer diameters include 50 mm, 75 mm, 100 mm, 125 mm, 200 mm, and 300 mm. The substrate edge detector 18 may be manually moved along the track 30 on the prealigner head 14. The substrate edge detector 18 may be secured into the track 30 by a spring and pawl which clicks into predefined positions corresponding to different commonly used substrate sizes. Alternatively, the positions for the smallest and largest substrates to be processed may be achieved by sliding the substrate edge detector 18 in the track 30 to the inner and outer hardware limits of the track.

According to an alternative embodiment, the substrate edge detector 18 may be moved along the track 30 on the prealigner head to accommodate substrates of different sizes automatically, such as, by a motor with position switches, by a servo controlled motor, or the like.

According to an alternative embodiment of a prealigner illustrated in FIGS. 11 and 12, two, three, or more substrate edge detectors 18 may be used on a single prealigner head 14. The advantage of having additional substrate edge detectors 18 lies in the reduction of scanning time due to the fact that different portions of the periphery of the substrate are scanned simultaneously by the different detectors. Thus, an angle at which the wafer must be rotated for a full scanning of the substrate is reduced by one-half for a two detector configuration or by two-thirds for a three detector configuration. In the embodiment of FIGS. 11 and 12, the substrate edge detectors 18 are supported in tracks 30 and are moved in the direction of the arrows B towards or away from the central chuck 16 in a sychronized manner so that the two substrate edge detectors 18 are positioned substantially equal distances from the chuck 16 during rotation of the substrate.

Upon rotation of the substrate S, the one or more substrate edge detector 18 collects data for determination of a displacement length, a displacement angle, and a flat angle. These valves may be calculated by the prealigner itself or by a

controller connected to the prealigner. The displacement length is a distance between a center point of the substrate S and a center point of the chuck 16. The displacement angle is an angle between a fixed reference line such as the axis of the end effector and the line connecting the center of the substrate S to the center of the chuck 16. The flat angle is the angle from the reference line to a line perpendicular to a flat reference surface of the substrate. The calculation these three geometric properties allows the prealigner to align the substrate on the end effector.

FIGS. 2 and 3 illustrate three wafer lift pins 20 which may be positioned around the chuck 16. The lift pins 20 are particularly useful for loading a prealigner 10 with a robotic arm having a blade-type end effector. FIGS. 4 and 5 illustrate the loading of a substrate onto the chuck 16 with an end effector 44 having a generally U-shape which accommodates the chuck between the arms of the U-shaped end effector. With the U-shaped end effector 44, relative vertical motion between the chuck 16 and the end effector transfers the substrate between the chuck and the end effector.

When a blade-type end effector 50 is used as illustrated in FIGS. 6 and 7, the substrate S is moved into the prealigner until the blade-shaped end effector 50 is positioned above the chuck 16. The lift pins 20 are then used to raise the substrate S off of the end effector 50 so that the end effector can be withdrawn. The lift pins 20 are then moved downward below the level of the chuck 16 so that the substrate S rests on the chuck for rotation of the substrate and collection of geometrical data. The lift pins 20 then lift the substrate S again so that the end effector 50 can pick up the substrate.

The prealigner 10 may include three or more lift pins 20 which may be placed symmetrically or asymmetrically around the center of the chuck 16. Alternatively, two or more lift bars may be used or one lift bar and one or more lift pins. The lift pins 20 or lift bars may include a vacuum feed to their top surfaces controlled by a vacuum valve or vacuum sensors to securely grasp the

substrate. The main purpose of the substrarte lift pins 20 is to enable the prealigner to be loaded with a blade-type end effector 50. Another possible use of the lift pins 20 is to place the substrate on the chuck 16 without moving the chuck vertically. The lift pins 20 have two positions including a lifting position at which the upper surface of the lift pins 20 is above the upper surface of the chuck 16 and the end effector and a retracted position at which the upper surface of the lift pins is below the chuck. For example, the lift position of the lift pins 20 may be approximately 5 mm above the chuck and the retracted position may be about 2.5 mm below the chuck, however, these values may vary significantly depending on the application.

FIGS. 8-10 show a robot 40 having robot arm 42 for transporting a substrate S to and from the prealigner 10. During the process of loading, aligning, and unloading the substrate, the robot arm 42 passes through the following three positions: vacuum exchange position, reference position, and retract position, shown in FIGS. 8-10, respectively. At the vacuum exchange position of FIG. 8, the robot end effector 44 positions the substrate S at the prealigner 10 and the substrate is transferred between the end effector and the chuck 16 of the prealigner. At the vacuum exchange position, the surfaces of the chuck 16 and the end effector 44 should be substantially parallel and the chuck should be placed in the center of the U-shaped end effector. At the vacuum exchange position, the distance D between the chuck 16 and the inside of the end effector 44 should be equal on both sides of the chuck as illustrated in FIG. 5. This distance D is referred to as the compensation limit. The angle E between the axis of the prealigner 10 and the axis of the end effector 44 is a calibration angle whose value is measured and used to obtain cooperative motion of the robot arm and prealigner.

The reference position, shown in FIG. 9, is a position of the robot arm 42 immediately before the arm moves the substrate S to the prealigner 10. The reference position allows for vertical motion of the prealigner head 14 up and

down without colliding with the substrate S or end effector 44. At the same time, the reference position should be relatively close to the prealigner for time savings.

The retract position, illustrated in FIG. 10, is a position of the robot arm 42 at which it is safe to rotate the robot arm about a central axis of the robot 40 with respect to workstations, cassettes, and other obstacles in the work space. The robot arm 42 may be retracted to the retract position at the beginning and end of the prealigning process. The retract position may or may not coincide with the reference position.

During the process of loading, sensing, aligning, and unloading, the prealigner head 14 also moves to a plurality of different positions. The different prealigner head positions include a zero or home position at which the prealigner head 14 is moved down close to the prealigner body 12 and is out of the way of the motion of the robotic arm 42 so that the robotic arm can be extended freely above the prealigner 10. A vacuum exchange position is a position of the prealigner head 14 at which the chuck 16 is level with the end effector 44 of the robotic arm. At this position, the vacuum valves of the end effector 44 and the chuck 16 may be operated for transferring the substrate S between the prealigner and the robot end effector at different stages of the aligning process. A data collection position of the prealigner head 14 is slightly above the vacuum exchange position. The prealigner head 14 is lifted to the data collection position to lift the substrate off of the end effector 44 and rotate the substrate to collect alignment data. Finally, the substrate loading position of the prealigner head 14 is slightly below the vacuum exchange position. The prealigner head 14 is positioned at the substrate loading position while the end effector moves a substrate onto or off of the chuck 16.

The robot system including the robot arm 42 and the prealigner 10 operate to perform prealignment on a substrate in the manner described below. It should be understood that this alignment procedure is merely exemplary and that other procedures may also be employed.

The alignment process includes five basic steps which will be discussed in further detail below including: 1) a substrate is transported to the prealigner 10 by the robotic arm 42; 2) the substrate is placed on the prealigner, rotated, and data is collected; 3) the robot arm compensates for the displacement of the substrate center; 4) the chuck 16 rotates the substrate until the substrate mark is at a desired angle with respect to the end effector 44; and 5) the robotic arm 42 removes the substrate from the prealigner 10.

Initially, the prealigner head 14 is moved from the zero position to a loading position which substantially matches the vertical elevation of the robotic arm. The robotic arm 42 picks up a substrate and moves to the reference position while the prealigner 10 is being matched to the vertical elevation of the robotic arm. The arm 42 is then moved to the prealigner pickup position at which the substrate S is positioned over the chuck 16. The prealigner head 14 is then raised to the vacuum exchange position and the substrate S is transferred from the end effector 44 to the chuck 16 by operation of the vacuum systems of the end effector and the chuck. The prealigner head 14 is then moved up to the data collection position at which the substrate is lifted above the end effector 44 and the chuck 16 is rotated to collect data. The substrate alignment parameters including a displacement length, displacement angle, and flat angle are calculated from the data collected by the substrate edge detector 18.

After data collection and calculation of alignment parameters, the end effector 44 is moved a distance equal to either the calculated substrate displacement length or the compensation limit D, whichever is smaller. If the end effector 44 is moved a distance greater than the compensation limit D, the end effector will contact the chuck 16 causing undesirable particulate generation. The prealigner head 14 is then moved down to the loading position transferring the substrate back to the robot end effector 44. The arm 42 is then moved back to the prealigner pickup position where the U-shaped end effector 44 is centered around the chuck 16. The prealigner head 14 is moved back up to the vacuum exchange

position to transfer the substrate back to the chuck 16. If the displacement length was not compensated in full because the displacement length was larger than the compensation limit D, the preceding data collection and prealigning steps are repeated until the substrate is centered. Once the prealigning steps are complete to center the substrate S on the chuck 16, the chuck is rotated by a value equal to the flat angle to compensate for a possible improper orientation of the substrate. The prealigner head 14 is then moved down to the exchange position and the substrate S is transferred back to the end effector 44. The prealigning is then complete, the prealigner head 14 is moved down to the zero position, and the robot arm 42 retracts to the reference position for further processing of the substrate.

Substrate transfer between the end effector 44 and the chuck 16 and vice versa may be performed in at least three different ways. As described above, the substrate transfer may be performed by movement of the prealigner head 14 with respect to the end effector 44 from the loading position to the vacuum exchange position at which the substrate is transferred to the chuck 16 and then to the data collection position where the substrate is lifted above the end effector. Alternatively, the substrate S may be transferred by vertical movement of the lift pins 20 or by vertical movement of the chuck 16 alone. According to a further alternative embodiment, substrate transfer may be performed by vertical movement of the robot arm itself.

The prealigner 10 which is movable independent of the robot arm 42 with which the prealigner is used provides significant advantages over both fixed prealigners and prealigners connected to robotic arms. The prealigner which is movable vertically and/or rotationally independent of the robotic arm permits more beneficial utilization of internal space within the robotic system. The vertically movable prealigner allows the vertical elevation of the robot to be matched by a similar vertical elevation of the prealigner. The vertically movable prealigner also allows the prealigner to be moved out of the way so that the robot arm can pass above the prealigner. The rotational prealigner head allows the

prealigner to be placed at different angles to achieve the most advantageous loading for a particular robotic system. The rotational prealigner head also improves transfer time by allowing simpler and quicker motions of the robot arm to load and unload the prealigner.

The adjustable height prealigner is preferably capable of moving vertically a distance which is equal to the vertical travel capability of the associated robot arm. One example of the vertical travel capability of the prealigner is up to about 15 inches, preferably up to about 20 inches. Examples of vertically extendable Z-axis platforms include those disclosed in U.S. Patent Application Serial No. 08/661,292, filed June 13, 1996, which is incorporated herein by reference.

FIG. 13 illustrates a prealigner 10 having a prealigner lift mechanism including a lead screw 60, a nut 62 which is moved vertically by the lead screw, and a motor 64 for driving the lead screw. The prealigner head 14 is supported on a movable platform 66 for vertical motion with respect to a bottom flange 68 of the prealigner. Connected to the movable platform 66 are a motor drive 70 for the chuck 16 and a carriage 72 having the nut 62 for moving the prealigner head 14 vertically. The lead screw 60 is rotated by the motor 64 by way of a belt drive 74. A linear guide 76 is fixed within the prealigner body 12 and guides the vertical motion of the carriage 72.

In operation, the prealigner head 14 is moved vertically by operation of the motor 64 to rotated the lead screw 60 which in turn drives the nut 62 and carriage 72 vertically along the lead screw. Accordingly, the movable platform 66 which is supported on the carriage 72 and the prealigner head 14 itself are moved vertically as desired by operation of the motor 64. The prealigner lift mechanism illustrated in FIG. 13 is merely exemplary of one of the mechanisms which may be used. Other lead screw arrangements and other mechanisms may also be used.

FIGS. 14-16 illustrate another alternative embodiment of a prealigner for alignment of flat panels or other multi-sided substrates. The prealigner 80 of FIG. 14 includes three substrate edge detectors 88a, 88b, 88c which are arranged with

two of the substrate edge detectors 88a, 88b in a parallel spaced apart arrangement and the third edge detector 88c positioned perpendicular to the two parallel edge detectors. The arrangement of the two parallel substrate edge detectors 88a, 88b allows the detection of rotational misalignment of the substrate. Two of the perpendicularly oriented substrate edge detectors (for example 88a and 88c) are used to detect linear misalignment of the substrate in two perpendicular directions.

In operation, the rectangular substrate R, shown in FIG 14, is carried by the robot end effector to the prealigner 80. The edges of the substrate R are inserted inside the three substrate edge detectors 88a, 88b, 88c. The X and Y direction misalignment of the rectangular substrate are determined and the rotational misalignment of the substrate in the horizontal plane is determined.

The prealigner 80 for rectangular substrates according to FIGS. 14-16 does not include a rotatable chuck or lift pins. The device is used to detect the actual position of the substrate on the robot end effector. After the actual position of the substrate has been detected, the robot itself may be used for to compensate for any misalignment during subsequent processing. Alternatively, the prealigner may include a chuck or lift pins which may be used for alignment of the substrate on the robot end effector in the same manner as the prealigner for circular substrates which is discussed above.

As in the previous embodiments, the prealigner 80 has a body 82 and a head 84 which is movable in the direction of the arrow A with respect to the body. The movable prealigner head 84 allows the prealigner to be adjusted depending on the position of the robotic arm to improve transfer time and allows the prealigner to be moved out of the way during subsequent processing of the substrate. The substrate edge detectors 88a, 88b, 88c may be fixed on the prealigner head 84 or may be movable.

While the invention has been described in detail with reference to the preferred embodiments thereof, it will be apparent to one skilled in the art that

various changes and modifications can be made and equivalents employed, without departing from the present invention.

Claims:

1. A prealigner for a robotic system, the prealigner comprising:

a prealigner body arranged to be mounted within the robotic system remote from a robot; and

a prealigner head movably mounted on the prealigner body to position the prealigner head at different positions with respect to the robot to improve transfer time of the robotic system, the prealigner head including a substrate edge detector for detecting a substrate edge.

2. The prealigner according to Claim 1, wherein the prealigner head includes a rotatable chuck for supporting and rotating a substrate.

3. The prealigner according to Claim 1, wherein the substrate edge detector is arranged to receive the substrate in a substrate plane which is substantially perpendicular to a direction in which the prealigner head is movable with respect to the prealigner body.

4. The prealigner according to Claim 3, wherein the prealigner head is movable in a substantially vertical direction by a motor.

5. The prealigner according to Claim 1, wherein the substrate edge detector is arranged to receive the substrate in a substrate plane which is substantially perpendicular to an axis of rotation of the prealigner head with respect to the prealigner body.

6. The prealigner according to Claim 2, wherein the prealigner head includes a plurality of lift pins for moving the substrate between the chuck and an end effector of a robotic arm.

7. The prealigner according to Claim 2, wherein the substrate edge detector is movable in a direction toward and away from the chuck.

8. The prealigner according to Claim 1, wherein the prealigner head includes a second substrate edge detector for detecting the substrate edge.

9. The prealigner according to Claim 1, further comprising a controller which controls a vertical elevation of the prealigner to substantially match a vertical elevation of a robotic arm during prealigning.

10. The prealigner according to Claim 1, wherein the substrate edge detector is a lighthouse including a light source and a light sensor.

11. A method of prealigning comprising:

picking up a substrate with a robotic arm;

adjusting a vertical elevation of a prealigner to substantially match a vertical elevation of the substrate on the robotic arm;

moving the substrate to the prealigner with the robotic arm; and

prealigning the substrate.

12. The method of prealigning according to Claim 11, wherein a rotational position of the prealigner is adjusted to improve transfer time.

13. The method of prealigning according to Claim 11, wherein following prealigning of the substrate, the prealigner is moved downward out of the way of the robotic arm and the robotic arm passes over the prealigner.

14. A robotic system, comprising:

a robot having a movable robot arm for transporting substrates; and

a prealigner which is movable with respect to the robot arm from a retracted position to an extended position to match an elevation of the robot arm with an elevation of the prealigner for loading and unloading the substrate.

15. The robotic system according to Claim 14, wherein the prealigner is movable longitudinally.

16. The robotic system according to Claim 15, wherein the prealigner is movable rotationally.

17. The robotic system according to Claim 14, wherein the prealigner includes first and second substrate edge detectors arranged in a parallel arrangement and a third substrate edge detector arranged perpendicular to the first and second substrate edge detectors for detection of the misalignment of a rectangular substrate.

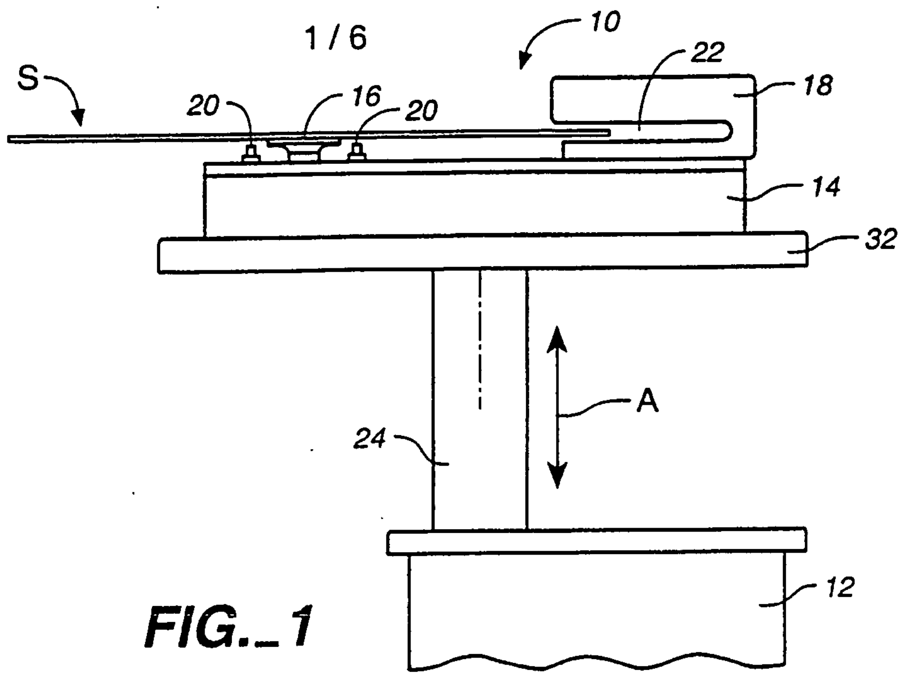


FIG._1

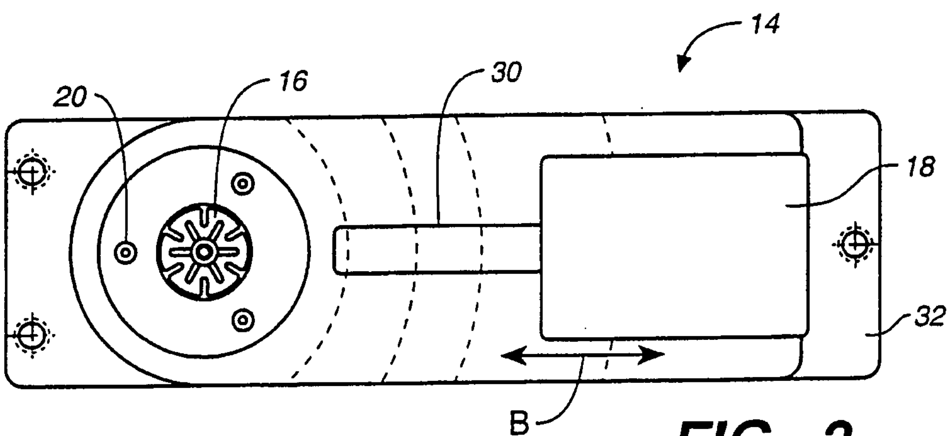


FIG._2

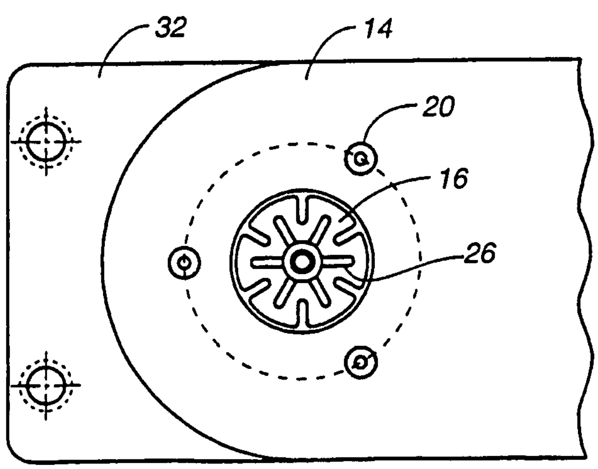


FIG._3

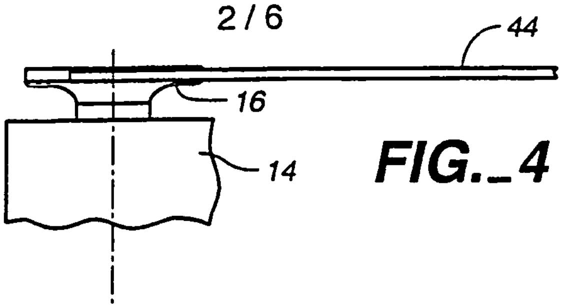


FIG._4

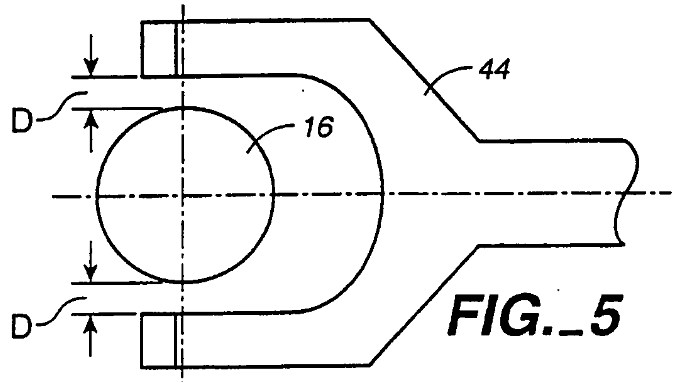


FIG._5

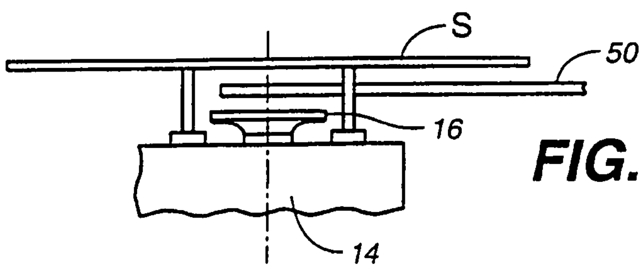


FIG._6

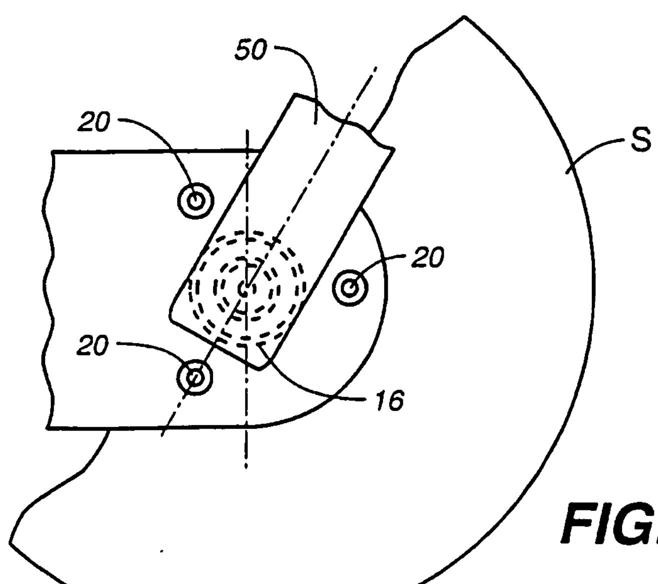


FIG._7

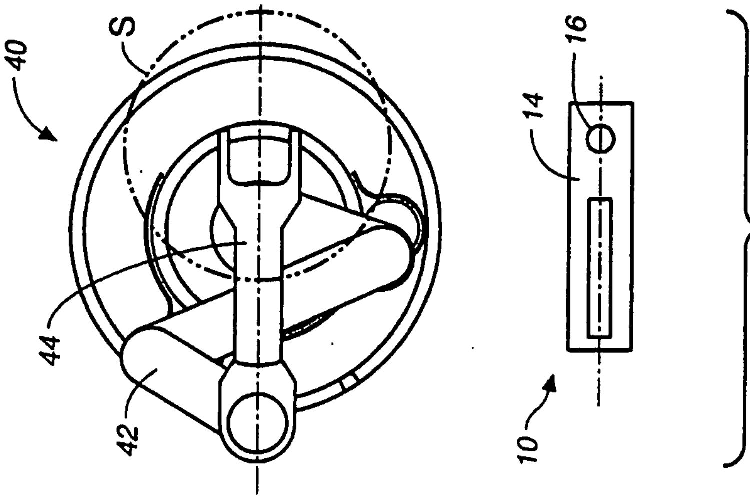


FIG._10

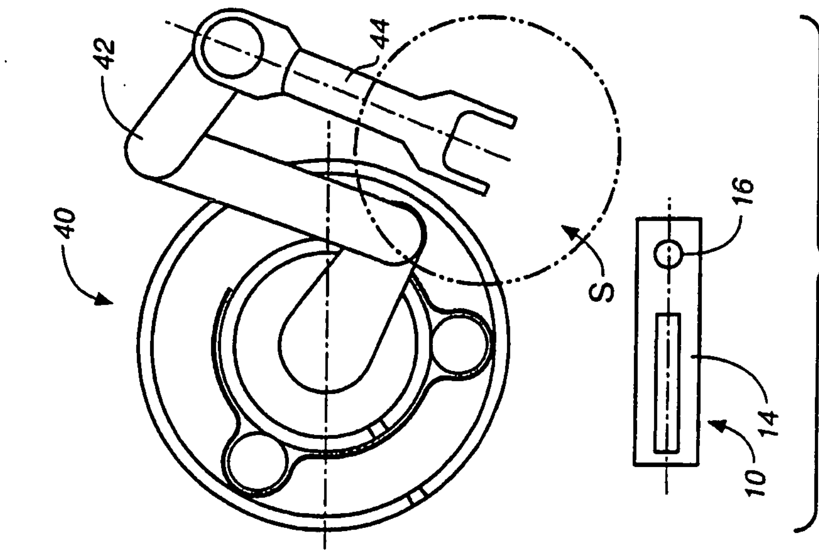


FIG._9

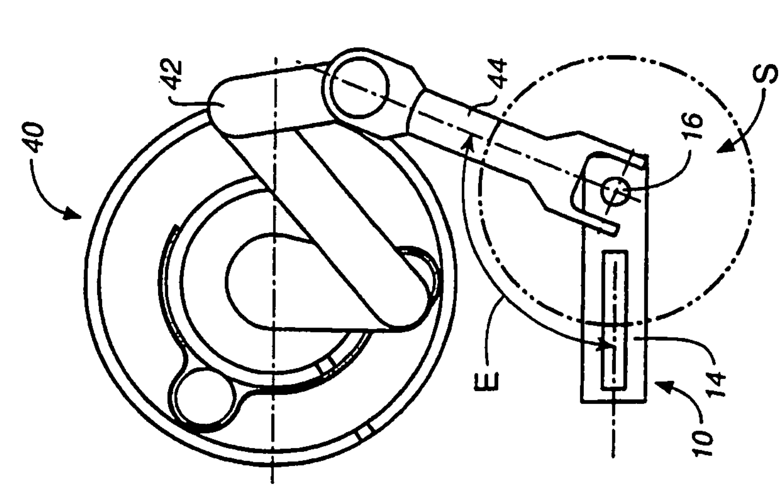


FIG._8

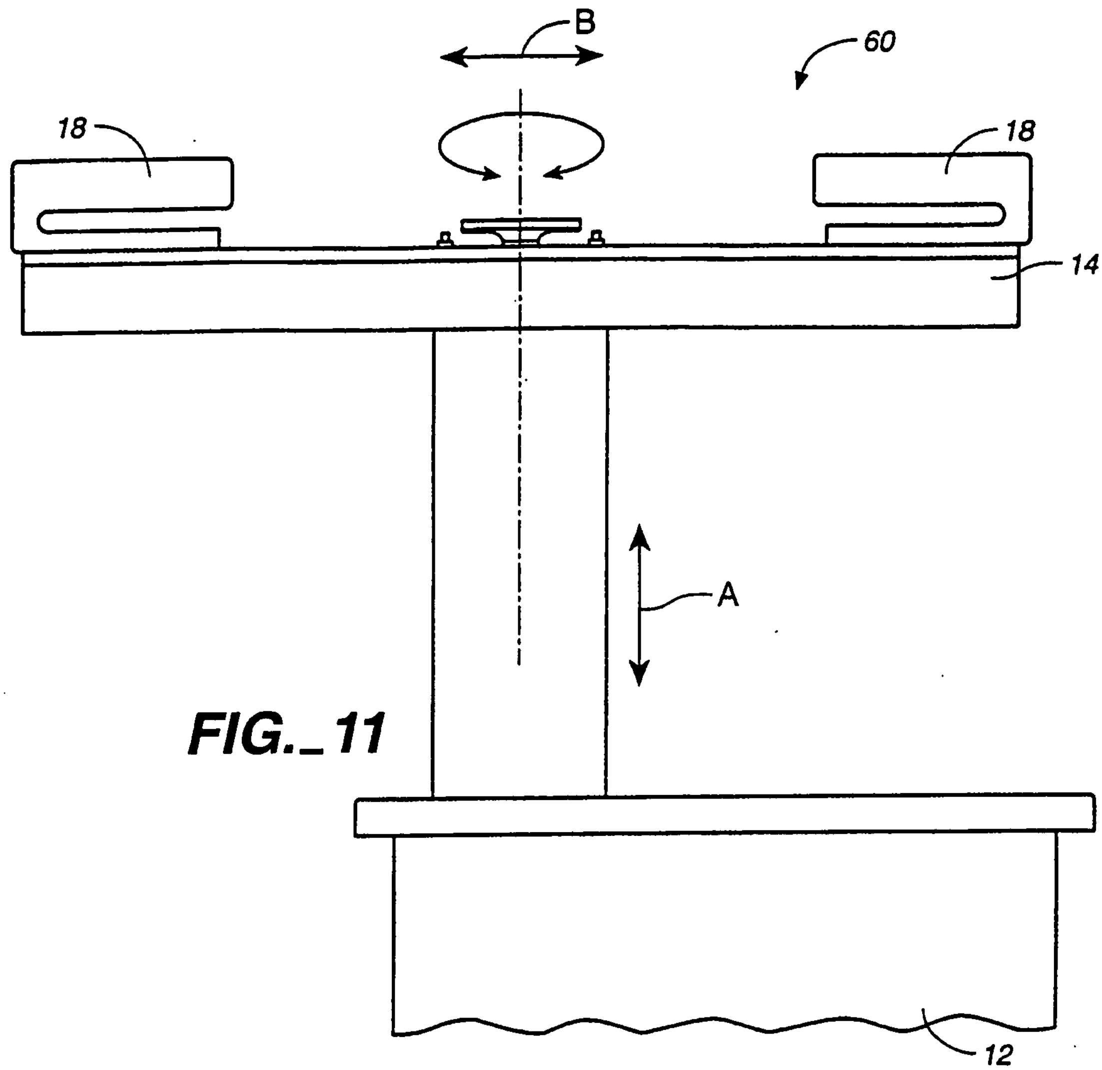


FIG._11

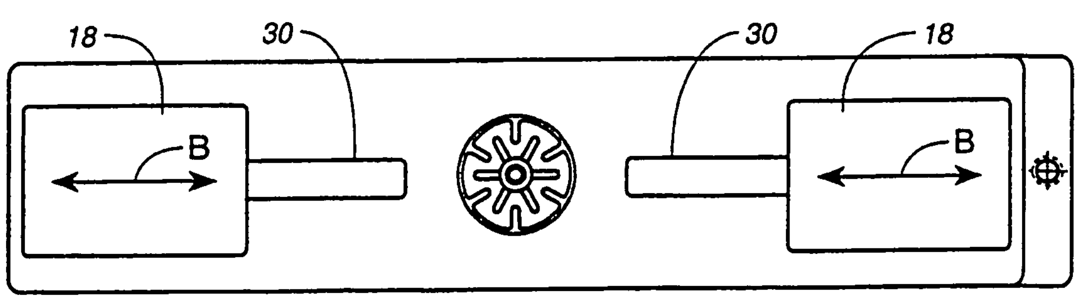


FIG._12

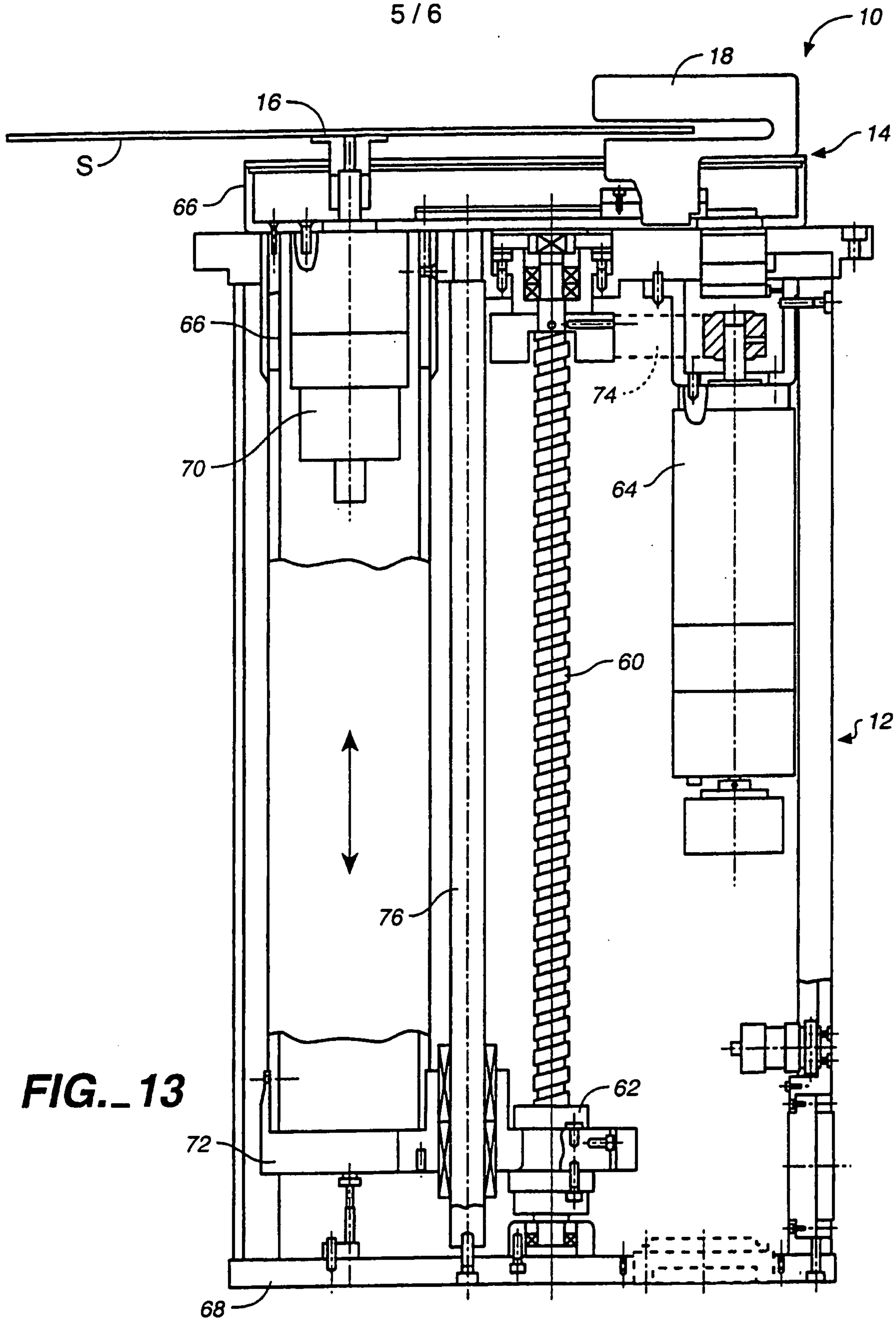


FIG._13

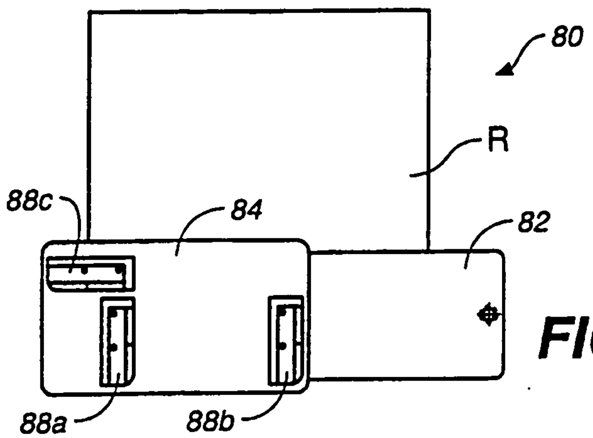
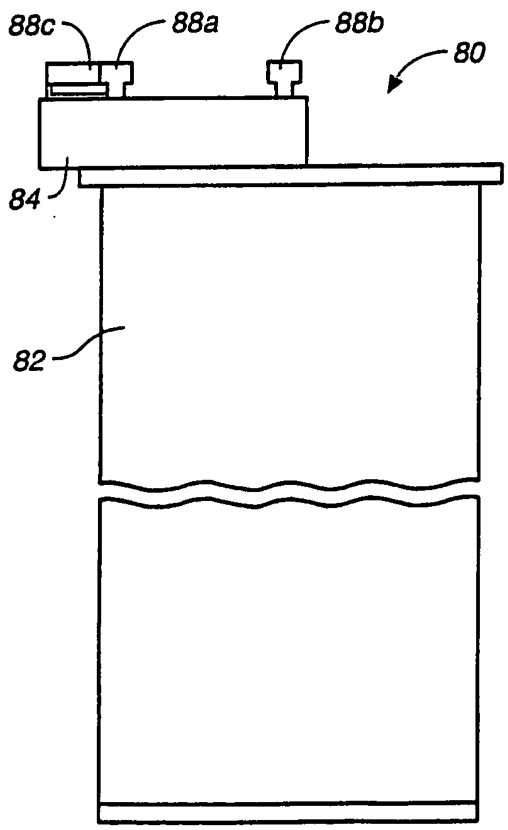


FIG._14



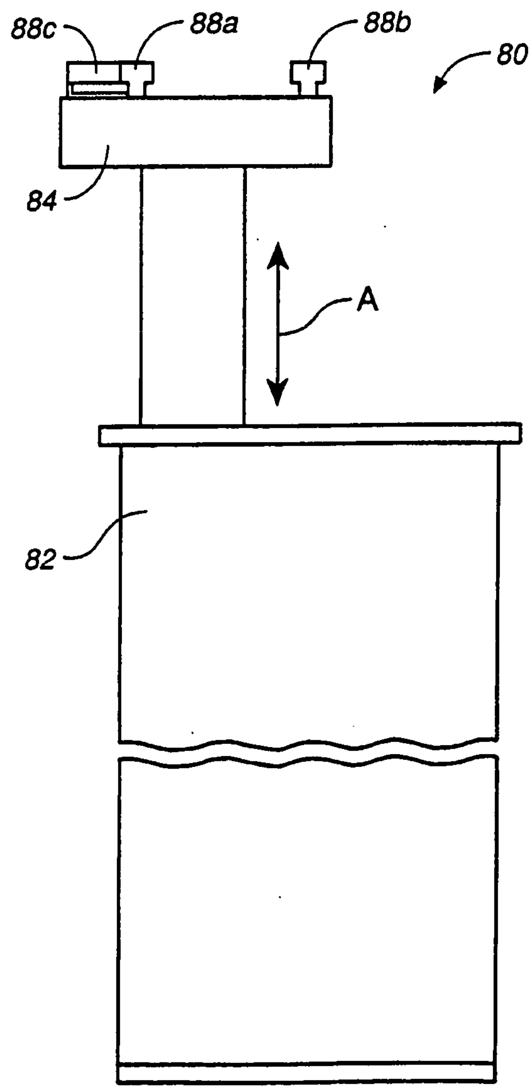


FIG._15

FIG._16

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/06545

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :B25J 09/10
US CL :414/783
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 414/783, 936, 941

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,770,590 A (HUGUES et al) 13 September 1988 (13/09/88), see entire document.	14-17
A	US 5,238,354 A (VOLOVICH) 24 August 1993 (24/08/93).	
A	US 5,452,521 A (NIEWMIERZYCKI) 26 September 1995 (26/09/95).	
A	US 5,456,561 A (PODUJE et al) 10 October 1995 (10/10/95).	
X	JP 1-164047 A (SAITO) 28 June 1989 (28/06/89), see entire document.	1-16

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 JUNE 1999	03 AUG 1999

Name and mailing address of the ISA/US	Authorized officer
Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	Janice L. Krizek Diane Smith for
Facsimile No. (703) 305-3230	Telephone No. (703) 308-2026

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